SCIENCE

VOL. LXV — APRIL 8, 1927 — No. 1684

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. — Garrison, N. Y.

New York City: Grand Central Terminal.

Annual Subscription, $6.00. — Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 3, 1879.

AGRICULTURE AND MODERN SCIENCE[1]

I FEEL a special sense of appropriateness in speaking on such a subject as "Agriculture and Modern Science" at Yale University. Much work in agricultural science has been carried on in Connecticut from pioneer days down to the present, largely under the leadership of Yale professors and investigators.

The earliest scientific paper on agriculture by a resident of the English colonies was that of John Winthrop, Jr., first governor of Connecticut, on the "Description, Culture and Use of Maize," read before the Royal Society in 1663. The Rev. Jared Eliot, of Killingworth, Connecticut, in the next century, is believed to have been the first American to publish a book on agriculture. Eliot, by the way, was a chemist. In 1764 the London Society for the Encouragement of Arts awarded him a gold medal for his process of making iron and steel from black magnetic sand.

Modern scientific study of agriculture in America may be said to have begun with John P. Norton, who undertook his duties as first professor of agricultural chemistry at Yale in 1847. Professor Norton, after making a promising beginning, died at the early age of thirty. His plans were carried to fruition by his pupil, Samuel W. Johnson, who held the professorship of agricultural chemistry at Yale for forty years, from 1856 to 1896. Professor Johnson is recognized as the father of agricultural research in the United States. The work which he did in the fifties as chemist of the State Agricultural Society in the analysis of fertilizers "for the information and protection of farmers" and the exposure of frauds attracted wide attention. As early as 1854 he advocated the establishment in this country of agricultural experiment stations and wrote: "What agriculture most needs is the *establishment of its doctrines*. . . . If agriculturists would know, they must inquire. The knowledge they need belongs not to revelation but to science, and it must be sought as the philosopher seeks other scientific truth."

Due largely to Professor Johnson's efforts the agricultural experiment station idea first took shape in the Connecticut station, which began its career at

[1] Address of the secretary of agriculture, at Yale University, New Haven, Conn., March 28, 1927, at 8: 15 P. M., under the auspices of the American Institute of Chemists.

Wesleyan University, at Middletown, in 1875. Professor W. O. Atwater, a former student of Johnson's, was made director. Professor Atwater laid the foundation of American scientific studies in human and animal nutrition. The station was incorporated as a separate institution in 1877 and moved to New Haven. Professor Johnson became director, and offices and laboratory were supplied by the Sheffield Scientific School.

Professor Johnson's contributions to agricultural science were many and valuable. "How Crops grow" and "How Crops feed" are agricultural classics. His influence in bringing science to bear on all the varied phases of agriculture was far-reaching.

The success of the Connecticut Experiment Station led other states to follow. Dr. Johnson was active in developing a wider interest.

Another movement which had an important bearing on the development of agricultural research was the establishment of the bureau, now the Department of Agriculture, and the land grant college system by congressional acts in 1862.

The Department of Agriculture from the beginning was planned to be a national research agency. It has been gradually developed along these lines until now it is the most extensive research agency of the kind in the world, expending for fundamental research bearing on agriculture in its larger aspects more than ten million dollars a year and employing more than a thousand trained investigators and in addition a corps of more than four thousand who assist in the work directly or indirectly.

In the development of the land grant colleges the needs for research as well as education were evident from the first. Research data on which to build a more scientific agricultural education were largely lacking. The earlier years of the colleges were therefore not impressive from the standpoint of accomplishment.

In 1887, largely through the efforts of the colleges, the Hatch act was passed. This recognized the joint responsibility of the federal and state governments for promoting agricultural research and provided $15,000 a year to each state for that purpose. This was later increased under the Adams act to $30,000, and recently under the Purnell act to a final total of $90,000 a year to each state. On the average, not counting buildings, land and overhead of that kind, the states provide in addition two or three times as much more.

The general supervision of the work on the part of the federal government devolves upon the Department of Agriculture through a special Office of Experiment Stations, provided by law for that purpose. The closest cooperation has developed in practically every phase of the work.

The three acts mentioned have somewhat different objectives. The first, the Hatch act, was general in its terms. The Adams act was designed to develop more fundamental research. The Purnell act broadened the field to include economic, sociological and home economic studies. In the earlier years problems of production, control of disease and insect pests, introduction and development of improved varieties of crops and animals, studies of fertilizers and soil fertility, feeding and breeding of livestock were paramount objectives. To-day these are not less important, but problems of marketing, finance, transportation and other economic and social aspects of agriculture are dominant and require the same careful study and analysis that have been given to the production aspects.

There is also a difference in point of view between the earlier and the later work in agricultural research. In the early stages, agricultural science borrowed heavily from general science, the discoveries in which it endeavored mainly to apply to agricultural problems. Latterly, institutions for agricultural research have themselves become contributors to scientific discovery to a constantly increasing extent.

Examples of agricultural progress through research may be found in practically every science and every group of sciences.

In chemistry the classic example is the early work on fertilizers. The foundations of this branch of agricultural science were laid by such chemists as de Saussure (whose "Chemical Researches upon Vegetation" was published in 1804), Boussingault, who introduced exact field experiments with fertilizers in 1834, and especially Liebig, whose epoch-making book, "Chemistry in its Application to Agriculture and Physiology," was published in 1840. Liebig's book was the foundation of modern scientific agriculture. His work inspired J. B. Lawes in England, who first began the manufacture of calcium superphosphate as a fertilizer and founded the first agricultural experiment station at Rothamsted.

One of the most brilliant examples of the benefits which have been conferred by chemistry upon agriculture is the Babcock test for determining the butter-fat content of milk. It won grand prizes at both the Paris and St. Louis Expositions. Babcock's invention, from the effect which it had in improving dairy herds, in securing the payment for milk and cream upon a fat percentage basis, in controlling the processes of manufacturing dairy products, and in regulating the purity of municipal milk supplies, has been of inestimable value to the American people,

although he himself, by generously dedicating his process to the public, has had no share in the vast financial benefits which others have acquired.

The importance of fundamental research in chemistry to agriculture is illustrated by the researches of Professor Sabatier, of France, upon catalysis. Sabatier directed attention to the great importance of certain contact agents, such as finely divided metals, in promoting chemical reactions. One of the first industrial applications was in the hydrogenation of liquid vegetable oils for the production of solid fats. The use of this process upon the hardening of cottonseed oil for the production of new shortening agents has added millions to the value of the annual cotton crop of the United States. Another application of catalysis in industrial chemistry is the Haber process for the fixation of nitrogen, the nitrogen of the atmosphere and gaseous hydrogen being made to combine under pressure and in the presence of a catalyst to form ammonia. This ammonia can then be converted into ammonia salts or oxidized to nitric acid for the production of nitrates, both of which are of immense value to agriculture as fertilizers.

Chemistry has also been of great help to agriculture in assisting in the improvement of crops by chemical selection. The selection of mother beets of the highest sugar content for seed production is an example of such an application of chemistry. The sugar content of the beet has been more than doubled by this means. A simple rapid accurate method for the determination of sugar was made possible by the invention of the polariscope by the French scientist Biot in 1840. This instrument in its valuation of the sugar-producing crops of the world has been worth many millions of dollars annually to agriculture and the agricultural industries.

The feeding of farm animals is no longer conducted by the happy-go-lucky methods of fifty years ago, but is performed in accordance with the strictest application of the laws of physiological chemistry. The newer knowledge of the food value of proteins and vitamins, so much of which is due to the work of Drs. Osborne and Mendel, of Yale University, has been a development of the twentieth century. The accurate measurement of the energy-producing value of foods, when consumed by the human organism, was first made possible by the respiration calorimeter of Professors Atwater and Rosa at Middletown, Connecticut, in experiments which were sponsored and financed by the United States Department of Agriculture. A similar calorimeter for work upon farm animals was erected by Dr. H. P. Armsby at the Pennsylvania State College, and the results obtained with this instrument have done much towards placing the nutrition of farm animals upon the basis of an exact science.

One of the most important applications of science to agriculture of recent years is the discovery in the United States and England of methods for the direct conversion of waste straw into barnyard manure, a matter of importance to farmers who have straw but lack the animals for changing it into manure. In the process as developed at the Rothamsted Experiment Station, England, the straw is heaped up in stacks, treated with water and ammonium carbonate and then allowed to stand. Decomposition of the straw advances rapidly and a black product is obtained which resembles in appearance and properties barnyard manure.

The profitable utilization of agricultural waste products has engaged the attention of the United States Department of Agriculture since the time of its establishment sixty-five years ago.

An early example of what chemistry has done in the utilization of agricultural wastes is the working up of cottonseed into useful commercial products. Fifty years ago, when the industrial utilization of cottonseed was in its infancy, the disposition of the refuse seed which accumulated about the cotton gins was a most serious problem. In some cases the seed was thrown into streams, but the pollution of the river water, which was caused by this practice, led to the passage of laws, still in existence, attaching a penalty to this wasteful method of disposal. In other cases the seed was allowed to decay in large piles, which, because of the objectionable odors, became a nuisance. Chemists were, however, busily engaged in studying the potential wealth contained in this wasted material with the result that to-day the utilization of cottonseed for the production of fertilizers, cattle feeds, oil, soap and other products is the second largest manufacturing industry of the south. The seed which was formerly wasted is now converted into products which are worth many millions of dollars. But the end has not yet been reached, and the efforts of chemists are now being directed towards the study of methods for converting cottonseed meal into a valuable food for man. A serious obstacle in this direction is the presence in cottonseed of a toxic substance known as gossypol, which, when consumed in too large an amount in certain meals, has caused the death of farm animals. A study of this toxic substance and of the best methods for its removal is now being undertaken in a collaborative research by the Bureau of Chemistry, Department of Agriculture, and the Interstate Cottonseed Crushers' Association. There is every reason for believing that the valuable protein constituents of cottonseed before many years will be made into safe and palatable foods for human consumption.

I have devoted much time to the discussion of chem-

istry in relation to agriculture, as I feel it is a subject of special interest to the majority of my auditors. Highly significant work has been done in many other sciences and in groups of related sciences, however, and I wish to present to you briefly a few typical examples.

The introduction and improvement of plants have proved very important to agricultural progress. The United States Department of Agriculture has introduced more than 65,000 different plants procured by explorers in various foreign countries. For the last fifteen years the increased wheat production from the establishment of durum wheats, introduced from Russia by the late M. A. Carleton, has been more than 20,000,000 bushels annually. The introduction of grain sorghums, the development of improved and adapted varieties and the devising of suitable cropping methods have accomplished much in extending safe farming into the drier parts of the central and southern Great Plains. The citrus industry has been greatly benefited by bud selection for nursery propagation, based on tree-performance records.

Methods of growing cotton have been revolutionized in recent years by the new method of thick spacing of "single-stalk" plants, based on a technical botanical discovery by specialists of the Department of Agriculture that the cotton plant has two distinct kinds of branches. The single-stalk cotton is earlier and more productive, especially under boll-weevil conditions or in short seasons. The yields are often increased from 10 to 30 per cent., or even from 50 to 100 per cent., or more under some conditions, by the new method.

Identification and determination of the causes of destructive plant diseases and the development of methods for their control have done much to add safety to agricultural practice. This work is, obviously, based on fundamental research in plant pathology.

Research in the field of soils involves physics, chemistry, biology and soil classification. The aim of the physicist is to make the soil a more efficient medium physically for the growth of plants. The business of the chemist is to determine the chemical nature of soils and to insure that the plants grown in the physically efficient soils are supplied fully and cheaply with the nutrient elements required for the best growth. To the soil bacteriologist the farmer looks when he wants to be sure that his soil will grow a particular kind of legume, and to him the farmer has not looked in vain, for science has made it possible to inoculate soils by means of pure culture of nodule organisms. The investigators in pure soil science are engaged in identifying individual soils and in classifying and mapping them. In this field of endeavor the United States is far in the lead of other countries, owing to the untiring efforts of Dr. C. F. Marbut, chief of the Soil Survey. The Soil Survey is the only scientific institute which gathers facts about soils of the whole country and shows their relationships. It has taken numberless centuries for men to realize that individual soils exist, and that the first step toward understanding them is to classify them.

Enormous aid has been given to agriculture through minute research dealing with insects that prey upon crops or livestock. Among the lines undertaken in parasitology is the investigation of the life histories of parasites. Much attention has been devoted to this by the Department of Agriculture.

For example, the Texas fever tick was found to pass its entire life from the seed tick to the engorged adult on a single host animal, and hence it was found possible to eradicate ticks by dipping cattle alone—which would be a much less adequate procedure if the ticks passed parts of their life cycle on other host animals as many ticks do.

The sheep stomach worm was found to ascend grass blades in the presence of moisture. This discovery directed attention to the danger from wet pastures and short grass. The parasite was found to reach the egg-laying stage in the intestine in about three weeks, leading to a recognition of the necessity of moving sheep to clean areas or else treating them every three weeks to prevent reinfestation.

Valuable studies have likewise been made in the correlations between the chemical composition and water solubility of anthelmintics and the value of these drugs in removing worm parasites.

A consideration of the chemical composition of chloroform as indicating that its value against hookworms was due to its chlorine content led to the development of carbon tetrachloride, a related compound, as an anthelmintic for use against hookworms. Since 1921 this has been generally used in veterinary and human medicine. It has been found of value against many kinds of roundworms in animals and has recently been found to be effective in destroying liver flukes in sheep, being the cheapest of the effective preparations known for this purpose. Pursuing the same line of investigation resulted in the discovery that tetrachlorethylene, another related compound, is equally effective against hookworms and is apparently safer. Further studies are being carried on with a view to developing from a chemical basis a drug which will be of value in removing several sorts of worm parasites not at present susceptible to satisfactory treatment with any one drug. It has been ascertained in connection with these investigations that the water solubility is a factor of importance and that

there is a point of optimum solubility which is approximately known at present.

The intimate structure of injurious insects, their physiology, their ecology and their various reactions are being minutely investigated.

These investigations have in many cases led to practical results. A very recent one relates to the Japanese beetle, an accidentally introduced pest which threatens great damage to American horticulture. Investigations of the olfactory sense of this species have led to the discovery of a chemical attractant that makes possible ready destruction of the adult beetles in great numbers.

Animal industry has profited greatly from the application of science to its problems. The importance of the vitamins and of light to the growth and development of animals is recognized by all. The significance of vitamin E, and possibly a vitamin which has an influence upon lactation has not so far been generally realized in applications to the industry.

The importance not only of the quantitative distribution of foodstuffs, but of the qualitative character of the constituents of an animal ration, has been discovered from investigations in both general and animal physiology in addition to direct studies of nutrition. Knowledge of the importance of an adequate supply of protein of a good qualitative character and of the nature of the deficiencies of certain proteins has been derived from reciprocal relations between studies in pure chemistry and in nutrition.

Our understanding of the gross nutritive requirements and the relation between the character of food and the production of work has been drawn from the fields of physics and physiology and applied through calorimetric studies on animals themselves. As the advances in animal nutrition are examined it is found that there always has been a close relation between studies in fundamental sciences, particularly those of chemistry, physiology and physics, and the final application of the principles developed to farm practices.

Destructive animal diseases have been brought under control by scientific means. Blackleg and hog cholera, for example, are now preventable at a merely nominal cost for vaccines.

The importance of meteorology to agriculture was early recognized here at Yale University, where Elias Loomis, who was professor of natural philosophy and astronomy from 1860 to 1889, became recognized as the foremost meteorologist of the United States.

As a result of research in this field, our climatology is now known, and it is possible to state where this or that crop can or can not be grown successfully. The relations of the yields of various crops to the prevailing weather conditions at their several stages of growth have been studied, and in many cases helpful estimates of yields can be made weeks and even months before harvest.

The duration and intensity of sunshine are of great importance to all varieties of vegetation, but very unequally so. Similarly the spectral quality of the light likewise is of great importance, not alone in vegetable growth but also to animal health. Studies of these relations are just beginning—a field of investigation that offers endless opportunities in pure science, and promises significant practical applications.

The applications of science to agriculture are important not only in production but in marketing—a field which is growing rapidly in significance to the farming of this country.

Pure science has a direct relation to the marketing of grain, notably wheat. The protein content of wheat has played an increasingly important part in the price paid for this grain at the large terminal markets during the past few years. The state of Minnesota maintains fully equipped chemical laboratories at Minneapolis and Duluth. Every car of wheat received at these markets is tested for the protein content and certificates covering the protein content of the wheat are issued by the state. The state of Kansas and the state of Missouri maintain a chemical laboratory at Kansas City for the same purpose. At other important terminal markets where wheat is received in large volume chemical laboratories are maintained by either the state or the local grain exchange. In addition many commercial chemists find a field for business in determining protein content of wheat.

This direct application of the pure science of chemistry to grain marketing is a comparatively new development. There is much room for it to expand still further. For example, the protein test now applied is for the purpose of determining the quantity of protein which the wheat contains. The quality of the protein is fully as important to the miller as the quantity. Up to date, however, no reliable, satisfactory method has been developed for determining the quality of protein in wheat. The development of such a test would probably revolutionize the system of buying and selling wheat in much the same way that the Babcock test revolutionized the dairy industry.

In considering the interrelationships of prices, marketings, supply, plantings, breedings and other questions, there is being developed a scientific approach in order to obtain quantitative answers. We are no longer satisfied, for instance, with the knowledge that bumper crops depress prices, or that low-priced feeds cause farmers to produce more livestock. We want to know the effect on price of a large crop (in dollars

and cents), and the exact number of pounds or the number of head of meat animals which will be forthcoming as a result of given feed prices.

In working with these problems it has been necessary to devise new advanced statistical methods—an example of the application of mathematics to agriculture. The reason that economists have not heretofore been able to express their observation quantitatively is that they have not been able to determine the conditions under which they made their observations. Unlike the natural scientists, they have not been able to take their problems into a laboratory to observe facts undisturbed by varying outside conditions. If, for example, they attempted to study the effect of the size of the domestic wheat crop on price, they were confronted by numerous complicating factors, such as the production of other grain crops, the production of wheat in foreign countries, the changes in the general commodity price level, and the fluctuations in business conditions. Now, however, by the use of correlation methods recently developed, these general factors can be isolated and their separate influences on each other measured.

The examples which I have cited, from many sciences and from many agricultural enterprises to which the results of research have been applied, merely suggest the debt which modern agriculture owes to science. It is no exaggeration to say that through the research accomplishments of recent years the average farmer to-day knows more of the science on which his industry rests and brings it into constant application than the scientist knew fifty years ago.

Yet there remains much to be done. The agricultural field is full of problems, a large proportion of which depend for their solution on the effectiveness with which underlying problems in pure science are dealt. American science, I am convinced, needs to concern itself more with fundamental research than it has done heretofore. No country in the world has made such progress in applied science, but our record in pure science is not so flattering. Since 1900, when the Nobel prizes in physics, chemistry and medicine were inaugurated, seventy-six awards have been made. Of these, twenty-four went to Germany, eleven to England, ten to France, six to the Netherlands, five to Sweden, four to the United States, three to Denmark, three to Swtizerland, two each to Austria, Canada, Italy, and Russia, and one each to Belgium and Spain. On the basis of population, the Netherlands, Denmark, Sweden and Switzerland received one to every million inhabitants; Germany one to every two and one half million; Austria one to every three million; England one to every three and a quarter million; France one to every four million; the United States, one to every twenty-nine million.

This is the situation despite the fact that we have vastly more students in colleges and universities in proportion to the population than has any other country in the world. The difficulty seems to me twofold: We are not laying enough emphasis on pure science in proportion to our emphasis on the applications of science; and we are not stimulating and training an adequate personnel in scientific research.

Indeed, superior personnel is needed in every field touching scientific work. There is grave need, as I have pointed out, for workers in pure science. There is need likewise for those who can correlate and coordinate the facts discovered.

There is demand also for those who can interpret and apply to practical problems the results obtained through scientific investigation.

The agriculture of the future will be successful in proportion to the extent to which it is shaped and guided by the basic facts revealed by scientific research, especially research in the fields of natural science, economics, engineering and business administration. If satisfactory progress is to be made in the solution of the diverse problems of the farm, to the end that agriculture may be more prosperous, the facts developed by research must be intelligently correlated and coordinated, superficials distinguished from fundamentals and the latter interpreted in the light of practical knowledge as well as scientific information.

Of supreme importance is a sufficiently numerous personnel characterized by outstanding ability, thorough professional training and unstinted devotion to the search for the truth. To the development and encouragement of such a personnel every organization concerned with science may wisely lend its hearty efforts.

W. M. Jardine

RESEARCH IN COLLEGES AND PROFESSIONAL SCHOOLS. II

A REPORT OF SUGGESTIONS FROM THREE CONFERENCES

I should like to bring to you some of my own thoughts as to the importance of encouraging research in colleges and professional schools and the results that should follow. I am frankly optimistic as to these results if—I should like to discuss the results and the if. But it seems more appropriate, instead, to review some of the suggestions that have come from conferences and a number of consultations with leaders in research and in college work.

Among university graduates who enter upon college teaching the research death-rate is too high. Its being so high is a disadvantage (a) to the men them-

selves, (b) to the colleges and (c) their students, (d) to the progress of research and (e) to the whole community.

Ceasing their research is disadvantageous to the young doctors of philosophy, for it deprives them of the fine stimulus, the great intellectual pleasure and the self-respect that contributing activity and the contributing attitude can give them in their field of study; and it prevents their normal growth.

It is disadvantageous to the colleges to have the research of their teachers cease, for the colleges need teachers with the vital spirit that can hardly reach full development in second-hand teaching. Men of positive judgments based on some first-hand, direct contact with the materials of their fields have an attitude in teaching far more inspiring to their pupils than can readily come from teachers who rely wholly upon others for their knowledge of their own fields. The difference in tone between partly first-hand and wholly second-hand judgment of the data and their relations will be reflected in teaching. The former will give a vital quality that is rarely possible to the latter. Quality of product, not mere numbers, is what a worthy college should desire in its graduates. Fewer hours of teaching per faculty member, with more vital quality of teaching means either a larger faculty or fewer students, but in either case it should mean a more valuable output of college product.

College students need and have a right to the intellectual stimulus that comes from contact with intellectually productive men. They should develop some main intellectual interest in college, should find an intellectual hobby. Just as a man needs throughout life some pet athletic sport to keep his body fit, so each man of normal capacity and development needs a central intellectual interest as a tonic to his whole mental life. Again, each man, for the sake of his own continued self-respect, should have a contributing attitude toward his job and the community, an attitude of first-hand study of facts and conditions, of first-hand judgments upon these and of initiative and of positive contribution. There is nothing so effective for engendering such a spirit of positive individual contribution as contact with those who exemplify this spirit, and where better than in college can these contacts be had?

More recruits for research are needed. Every man engaged in research finds his studies opening vistas along many most interesting and important paths which he can not himself follow. Each piece of work entered upon opens up dozens of others. "The harvests truly are plentiful but the laborers are few." A much larger proportion of our abler college graduates should choose the life of research—a *much* larger proportion. Some men of course have to provide food and clothing for our bodies, and this army of common laborers needs executive leaders. But the problem of better adjustment of human lives to the realities in the midst of which we live demands not only, and not even chiefly, the proper application of truth as already grasped. It demands much more the search for further truth. Man needs more, and better, more nourishing, truer food for his mind and more grace and beauty to clothe his spirit. A much larger proportion of our abler college graduates might well devote their lives to the search for truth and beauty (two aspects of the same thing), to the search for sounder knowledge of the realities in the midst of which we live and to which we must relate ourselves.

But how can college students be expected to choose the life of research for truth, unless by their junior and senior years, when their life choice is usually made, they have had contact with lives devoted to research? How can such a life be presented vividly to their imagination? The spirit of devotion to truth and its fuller discovery is highly contagious. Let our college teachers be centers of such contagion.

Each individual according to his capacity needs the independent, individually productive spirit which research develops. Independent study of one's job, study of larger truth with the thought of contributing something—the individual needs this for the sake of his own fun in the game; the community needs it and has a right to ask it from each individual according to his capacity.

To furnish leaders of this type our colleges need, first, teachers imbued with the research spirit as well as the teaching urge. They need also some semi-research courses, courses using semi-research method. The two together will be a lure to lead larger numbers of the ablest college graduates to choose the productive intellectual life, the life of research.

Much encouragement, in the form of scholarships, fellowships and assistantships, is given in our universities to graduate students. A few of the ablest of the young doctors of philosophy are still further aided by fellowships, such as the National Research Council fellowships, which enable them to continue from one to three years longer in uninterrupted research. But a much larger number, including many of marked ability, go into the colleges as teachers and there in large part become swamped by too heavy teaching burden and their research purpose proves not strong enough to resist the pressure of overwork and the deadening college environment. Among these young doctors engaged in college teaching the research death-rate is disappointingly large. Can anything be done about it? Is it worthwhile to try to do anything about it?

Several conferences upon the subject that have been held between teachers and administrators from a good many colleges have unanimously said that the situation is not hopeless; that something can be done and that it's worth doing. That the situation is not hopeless, that good research and a good degree of the research spirit is possible in college, is shown by conditions that have obtained and that obtain to-day in a number of colleges. To mention but a few:

Carleton College has for years had a strong, productive department of astronomy, which has published the dignified journal, *Popular Astronomy.* The mathematics, physics and chemistry departments have also had strong research men.

In Swarthmore, also, astronomical research has long been emphasized and with it mathematics and physics.

Dr. Goodrich will tell us of Connecticut Wesleyan University, which has a long tradition of research.

Amherst has long supported research and productive scholarship in both science and literature.

Dennison had for years a highly productive department of biology.

In Oberlin all but one or perhaps two of the science faculty are engaged in worthy research, and two thirds of the other members are engaged in advanced scholarly productive study.

Lafayette was for years a center of stimulating influence in English literature.

In Princeton, for years before it became really a university for graduate training in research, there were departments strong in research.

Bryn Mawr is really a university and so is not mentioned here.

And so on. Colleges as such, in distinction from universities, have shown that they can maintain, and expose their students to, an atmosphere of research either in many or at least in some departments.

From the several conferences of college representatives upon research in colleges there have come a large number of practical suggestions as to specific needs and procedures. Let us especially emphasize a few of these:

General recognition by the whole college and its constituency of *the legitimate place of research in the college* and of its essential importance if the college is to be intellectually strong and most effective in its stimulus to its students. An atmosphere encouraging to research, a general expectation that the teachers will be engaged in research. Interest in the research that is going forward. Recognition that his research is part of the service by which the teacher justifies and earns his salary. There should be a general expectation that summer vacations be given to productive scholarship. A man in good health who customarily employs his vacations otherwise should be looked at askance. Advancement in position and in salary should be on the basis of success both in teaching and in research.

The second great need recognized is release of part of the *teacher's time and energy for research.* Every college should have a clerical staff sufficient to relieve teachers of clerical work. It is a waste of money and, far worse, a waste of men, to use teachers for work that clerks can do. A reasonable teaching schedule should be adopted and not exceeded. Two full courses for one semester and one for another semester has been suggested. The half-semester free, plus the summer vacation, gives the teacher about half of his whole year's time for research. In this connection small classes and enough teachers were urged.

Changes in these directions involve additional *expense.* Generous contributions to aid colleges to put all teachers of proven capacity (and only such are best worth having) on a part-time research basis and to relieve all teachers of clerical work and of too heavy teaching schedule may be necessary before all that is desirable can be accomplished, but all who have discussed the matter at our conferences are convinced that much can be done without greatly increased cost if its desirability and importance is clearly recognized in the colleges themselves.

A list of numerous suggestions was published in *School and Society,* November 20, 1926. Of these some may be mentioned here. This will involve my overstepping a little the time limit accepted by the other speakers, but it seems appropriate to give more than fifteen minutes to a report of suggestions from over ninety men who gave careful consideration to the whole matter.

I

Cooperation between universities and research institutions, on the one hand, and colleges, on the other hand

(A) Consultation trips by college men to the research centers for advice and conference and reading.

(B) Exchange of teachers between universities and colleges (and perhaps exchange of research men between industry and the colleges).

(C) Loan of equipment and books.

II

Cooperation between colleges

(A) Consultation trips for men interested in related problems to confer for mutual aid.

(B) Loan of equipment and books.

(C) Exchange of faculty members for a year or for a semester or for a lecture course.

(D) Joining in securing visits from leading scholars, combining on special lecture plans, etc.

III

Within the individual college

Give promotion of research a place in faculty meetings a parity with teaching problems.

Give research, as a matter of course, recognition in the ndget of each department of study; grants for apratus, literature, research assistants, etc.

Have special research fund for special grants, this to administered by the research committee. This emasizes the dignity and importance of this committee.

Give stenographic and clerical assistance to faculty embers to conserve their time and energy for teaching nd research.

Cut down hours of teaching—a maximum of two full ourses (5 hours each) one semester and one the other emester suggested as a standard, the remaining time *be used for research,* summer vacations included.

Large faculties, small classes.

Leaves of absence, on salary, *for intensive study.*

Assistance toward expense of attending professional ociety meetings.

Special honors to men successful in research:

(A) Research as well as teaching success recognized s a basis for promotion.

(B) Special professorships for those markedly successful in both research and teaching, with added time and ssistance for research, and additional salary.

(C) Occasional appointment for a limited period to research positions with full time for research. These research appointees might naturally be chosen from the members of the faculty.

(D) Invitation to give college lectures, and publication of these lectures, with allowance of time for preparation.

Encouragement of research for the M.A. degree; also special stipends for M.A. students who shall assist professors in their research.

Research scholarships for outgoing seniors and for recent graduates to study in research institutions.

Develop the library for assistance to research as well as for teaching.

Some General Policies

Have no upper limit in rule or practice for aid to the able man when discovered.

Encourage research in all fields, not over-emphasizing any subject or group of subjects. Fear has been expressed lest other than scientific subjects be neglected.

Emphasize the fact that there are many problems of interest and importance, for research, within the immediate environment of each college, and that aid and cooperation in their study may often be secured from local organizations and institutions, including chambers of commerce, clubs, schools, historical societies, etc.

Suggestions of Possible Organization to Promote Research in Colleges

A *Research Committee* in each college, appointed or elected on such plan as the institution thinks best, but it was suggested that the inclusion of representatives from faculty, administration and trustees would be valuable.

A *Liaison Member* from each local committee for consultation with similar members from the committees in other colleges.

In time there may develop need for a small *Executive Committee,* elected by the liaison members to act for them in aiding in every possible way research in the colleges, with such *Officers* as the executive committee shall recommend and the liaison members approve. Possibly ultimately a central *Office* with staff might be found necessary.

Functions of Local Research Committee

Promote appreciation of importance of research on the part of all members of the college community, including trustees, administrative officers, faculty, students and donors.

Survey and list the researches in progress in the institution.

List the more important researches published in the past from the college.

Gather and classify information in regard to the entrance of graduates upon research, and list the ablest research men among the past graduates of the college.

Learn, classify and list the assistance needed for (A) researches in progress; (B) researches it is desired to undertake. Assist in plans for securing such aid.

Publish all these items for circulation in the college community.

Publish an annual report for circulation in the college.

Assist in securing cooperation between faculty members in research.

Study and suggest possible correlations between researches under way in the college.

Consider publication of research results—perhaps advisable, especially for studies of local environment. Publication assistance is especially needed in the so-called "humanities." Avoid encouraging publication of unworthy papers.

Secure a liberal research fund, grants from which shall be administered by the research committee.

Exchange with local committees in other colleges information as to methods and success in promotion of research.

Encourage teachers to present their subjects from the standpoint of their development through research, both the past development thus accomplished and the need of further studies to fill gaps in present knowledge and to extend it. All college work should be from the standpoint of growth of knowledge.

Arrange for presentation to the students, by men from the several departments and from outside the college, of the life devoted to research, and present newer phases of progress in knowledge, discussing also the men through whose research mankind have made great advance. Encourage establishment of societies and fraternities which cultivate research.

Encourage work by semi-research methods in the curriculum, putting some of this work as early as the Freshman or at least the Sophomore year, so that its tonic effect may be felt in later work. All college work may well be more by the research method than is now the case.

Present research to community by lectures and exhibits.

Urge value of administrative assistants to relieve faculty members of detailed committee work.

At Smith College attempt is made to put each teacher's classes at one end of the week, leaving study and research time freer from conflict with classroom duties.

Functions of Intercollegiate Executive Committee and Officers

Study problem of encouraging research in colleges and serve as a clearing-house for exchange of suggestions as to methods of promoting research:

(A) by publication of data and discussion,

(B) by correspondence,

(C) by promotion of regional and national conferences discussing promotion of research in the colleges and its relation to successful teaching. Research promotion should have a place on college association programs.

Serve as an agency to bring together in thought and action the colleges and the several organizations interested in the promotion of research in the colleges. Numerous learned societies and other organizations have committees on this subject.

Survey the colleges as to research status, teaching demands upon the time of the faculty members, etc. Perhaps publish results of such survey.

Study sources of aid for research, in and outside the colleges.

Assist individual colleges, or the colleges as a whole, to give and obtain aid for research.

Assist individuals to obtain help, financial and other, in their research.

Study the relation of college work in the past to the stimuli which led men into the life of research.

Develop recognition of the importance of research in the colleges—especially on the part of boards of trustees, administrative officers and those determining college policies.

Help secure for less experienced workers advice from leading scholars in choosing and directing research.

Aid in promoting cooperative research by bringing into contact advisers, workers and supporters in such work.

Aid in exchange of teachers between colleges, and between colleges and universities, also perhaps between industry and colleges there might be exchange of research men.

Assist in securing and arranging lecture courses, and more extended periods of resident work, by leading scholars, several colleges cooperating.

Aid in forming regional societies for cooperation and stimulus in scholarly interests. Neighboring institutions might form interinstitutional groups in different subjects of study for mutual stimulus.

Publish, at least annually, reports upon research in the colleges and its promotion.

Maynard M. Metcalf

The Johns Hopkins University

RESEARCH EXPERIENCES AND PROBLEMS IN A SMALL COLLEGE

This paper is prepared by request to present the conditions that have made and are making original work possible in a small college. It has been expected that statements should be definite and explicit and therefore I ask your indulgence when it seems to me necessary to refer to names and events connected with the history of a single college which is here represented.

Wesleyan University was established in 1831. Some think that a certain liberal outlook of its founders had bearing upon its later history. I will, however, pass over those considerations and mention at once an important period. We are familiar with the change in American universities leading to a greater recognition of scholarly work of which the founding of Johns Hopkins University in 1876 is often taken as a convenient landmark. By virtue of certain fortunate circumstances Wesleyan University was able to participate in this change. In 1873 the curriculum was revised, allowing more free election and bringing in new subjects for study. This necessitated an increase in the faculty student ratio. Previously it had been of the order of one teacher to eighteen students. After this it climbed rapidly to the neighborhood of one teacher to eleven students. In the accompanying chart (Fig. 1) a comparison is made between the number of students and faculty throughout the history of the college. (Line A is a graph of the number of students divided by 10 and line B shows the number of the faculty exclusive of the president and administrative officers.) Here may be noted the change in faculty student ratio occurring between 1873 and 1888. This revision of the curriculum giving broader interests and requiring a larger teaching force was the work of John Monroe Van Vleck and William North Rice. These two men also realized the value of research and by their counsel in the selection of new members of the faculty greatly aided in the introduction of this new element into the life of the college. In 1873 Wilbur O. Atwater became a member of the faculty. With the coming of Atwater, we find the first record of graduate work and the first beginnings of any continuous scientific investigation. His enthusiasm carried him outside of the college in search of financial support. This was received from private donors and later from the state, from the national government and from the

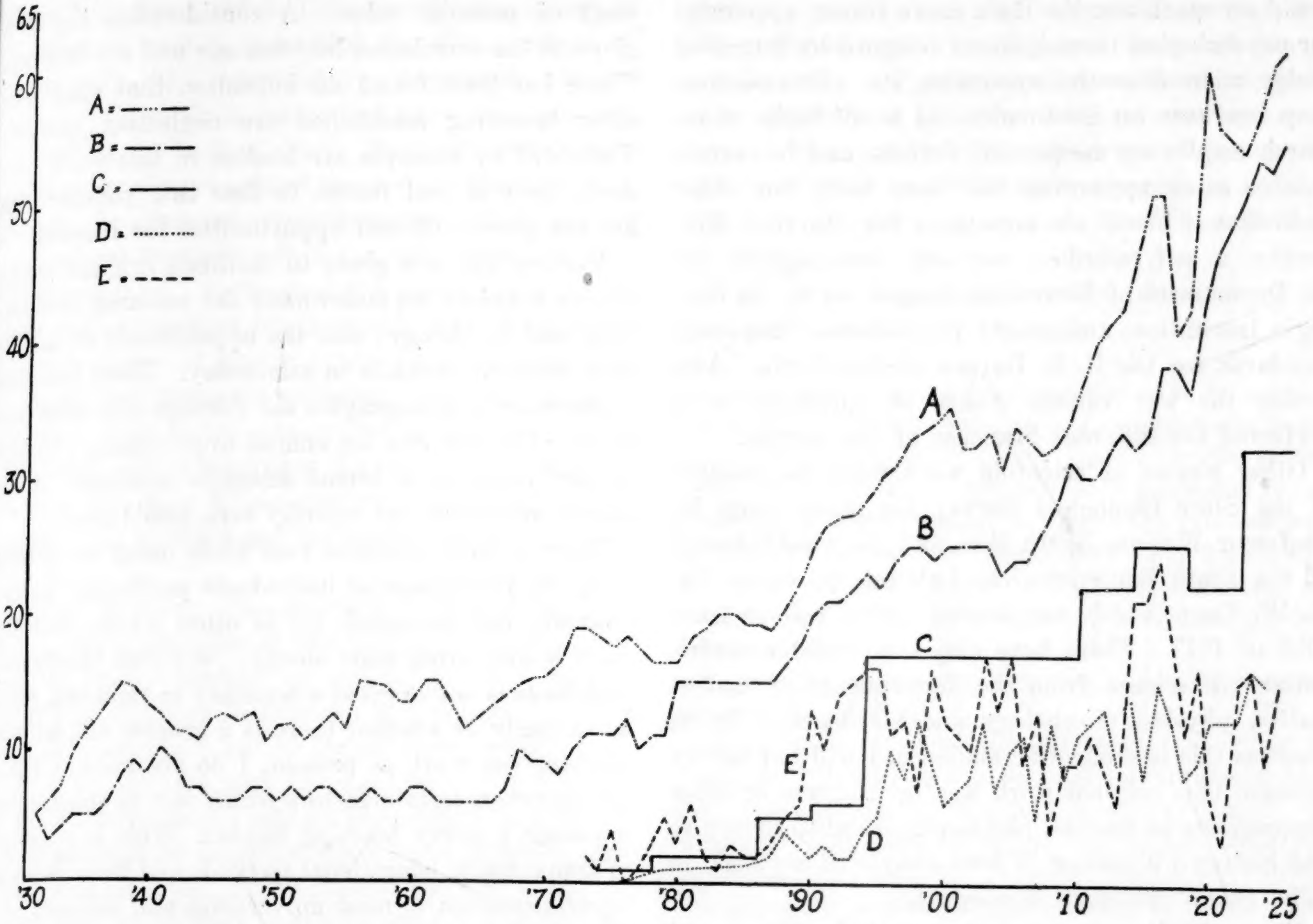

FIG. 1. Vertical distances indicate numbers of individuals; horizontal distances show calendar years from 1830 to 1926; line A shows the total number of students (graduate and undergraduate, *divided by ten;* thus when lines A and B approximate the ratio of one teacher to ten students is approached); line B, the number of members of the faculty not including the president and administrative officers doing no teaching; line C, the number of individuals in faculty publishing original results within four-year periods; line D, the number of individuals in faculty publishing original results during a given year; line E, the number of graduate students.

Carnegie Institution. For a college he was an extreme type. His chief interest lay in research. His example and precepts were one of the strongest influences in establishing in the minds of the faculty, trustees and alumni that research was a function of the college teacher.

In 1887 the college established an annual bulletin which has carried since its first year a record of all scholarly publications of the faculty (giving precise statements of title, journal and page, etc.). By means of this I have noted a remarkable rise in percentage of faculty participation in research beginning in 1894. The enthusiasm had spread to other members of the faculty and the increase in student enrollment during the eight preceding years had necessitated new appointments, and research ability had obviously been considered. This was also the period of the building and first operation of the Atwater-Rosa calorimeter and it brought upon the campus a corps of research assistants subsidized by the federal government.

The effects were clear. For example, during the period from 1902 to 1905, 75 per cent. of the faculty were making research contributions, and a survey of the last four years, 1922 to 1926, shows a similar percentage. There is some indication that certain conditions, which I will mention later, tend to retard the present rate of output, though apparently not reducing the numbers of faculty participating.

On the chart line C shows the number of the faculty participating in research within four-year intervals and line D indicates the number of individuals publishing their results each year. In neither case are the actual number of papers indicated which would be greater in the case of the publication of more than one paper each year. I deemed it of more importance to find the percentage of faculty participation rather than the amount of work accomplished.

There were certain minor aids to research. In 1891 on recommendation of E. B. Rosa a college machine shop was established, which has been maintained ever since. The expert machinists in college employ have made many scientific instruments of utmost precision. These included the Atwater calorimeter, Bradley

liquid air machines, the Rosa curve tracer, apparatus for psychological investigations designed by Raymond Dodge, micro-dissection apparatus, etc. This machine shop has been an inestimable aid to all fields of research employing mechanical devices, and in certain notable cases apparatus has been made for other institutions: liquid air apparatus for Harvard University, a self-recording magnetic declinograph for the Department of Terrestrial Magnetism of the Carnegie Institution, and quartz piezo-electric frequency standards for the U. S. Bureau of Standards. Also during the war various pieces of apparatus were perfected for different branches of the service.

Other phases of scientific work were the conduct of the State Geological Survey for many years by Professor William North Rice and the establishment of the State Bacteriological Laboratory, under Dr. H. W. Conn, which was housed by the college from 1905 to 1917. There have also been notable contributions in science from the departments of mathematics, physics, psychology and astronomy. In as much as this is a scientific audience, I will but merely mention that original work was in progress in other departments as classics, philosophy, English literature and history (Woodrow Wilson completed his book on "The State" while at Wesleyan).

The publicity given creative work by its annual record in the college bulletin has undoubtedly had its place as a spur to work, though sometimes criticized as breeding undue haste and superficial performance. Ability in research became one of the criteria for appointment and promotion, although in some cases wisely or necessarily waived.

If I may summarize the factors of the past we may say that the college took its place in the wave of scholarly advance of the American universities on account of the presence of at least two men who were alive to the values of the new phase and because of the advent of a most enthusiastic research worker. His energy and success gave the necessary stimulus which was a most important factor leading to a constant increase in numbers of men with capacity for original work.

This brings me to a survey of present conditions and problems. The present enrollment shows 621 students, including seventeen graduate students, a faculty of fifty-seven, including administrative officers, thus showing a faculty student ratio of about one to eleven. If from this list are eliminated members of administration doing no teaching, and the department of physical education which now includes athletic coaches, it has been found in a survey just completed that from the remaining fifty, thirty-five, or 70 per cent., have at least a definite research program. Seventeen, or 34 per cent., actually published last year work of research value. A consideration has been given to the correlation between age and productivity. There has been found no indication that older men after becoming established are neglecting research. They still by example are leaders in this work. Indeed, there is real reason to fear that younger men are not given sufficient opportunities for research.

Various aids are given to facilitate original work; as, for example, an endowment for research in chemistry and in biology; also the appointment of a full-time research associate in astronomy. There has been an increase in stenographic aid (though still quite limited). There is now an annual appropriation to pay in part expenses to attend scientific meetings. A research committee has recently been established.

There is some evidence that while many are taking part, the percentage of individuals publishing papers annually has decreased, or, in other words, that the work is appearing more slowly. Whether this means that there is not so great a tendency to rush into print as formerly or whether there is a greater difficulty in carrying out work at present, I do not know. There are, however, certain factors which just at present are imposing a heavy teaching burden. This is a period of transition in educational methods and there is much experimentation in most universities and colleges. At the elementary end there is the desire to establish orientation courses and in the later years special attention is given to the "gifted students." I believe these new methods in the end will give us a better educational system, but there is a tendency to superimpose the new things without removing the antiquated elements and thus to increase at least temporarily the teaching load. The difficulty may be met by increasing the faculty student ratio, but this is expensive.

A comparison of departments having a notably heavy student load per instructor with those having the lightest loads shows clearly that research is easier in these latter cases. These represent a student faculty ratio, which, if extended to the college as a whole, would be of the order of one member of the faculty to eight students. Clearly another factor—the personal equation—is also very important, as there are certain exceptions to this generalization.

I would like to mention one more point before proceeding to a final thesis. It has been abundantly proven that members of the faculty are capable of more creative work of high quality if given the opportunity. For example, when aided from the outside by provision of research assistants, or by more time, as when in technical war service or on leave of absence, there have been notable accomplishments. Had the number of papers been indicated on the chart, certain crests would be noted (beginning with Atwater's work) when individuals or departments re-

ceived some extra aid and the output was increased. I, therefore, wish to insist that the ability exists. It awaits only the opportunity. At present, and undoubtedly formerly in individual cases, research is at a standstill for lack of time. But time costs money.

There has always existed one serious question in regard to the place of research in the colleges. They have prided themselves in doing better teaching than the larger units. In the past this idea has been based in part on statements by university men in regard to the percentage of students who have been led into graduate work from the university and from the small college. These statements appear to favor the latter. The small college fears that if research is greatly emphasized, teaching will be neglected—teachers will lose contact with students and the intellectual stimulus will be lost.

I feel, however, that common ground is in sight. For example, the present educational "urge" to stimulate the "gifted student" by special problem methods or by participation in research is a method in which only creative minds can be the effective teachers.

It is my opinion that for some of our smaller endowed colleges there exists an exceptional opportunity to experiment in intensive educational methods, provided that they will curtail further increase in student enrollment while their resources grow. The problem of salary scale is also involved. In my opinion the best criterion is that it should be such that a reasonable number of the best students will be attracted into the profession. This is not at present the case, although there are indications of improvement since the post-war depression period. One can not be blind to the fact that such an intensive program involves a serious financial problem. Funds are needed. Research time is expensive. This program, however, will yield more time for research without diminishing the amount of attention which the individual student receives from the faculty. There will be a more carefully selected group of students introduced into an atmosphere more charged with intellectual life. If, on the other hand, these colleges grow as in number of students their resources grow, the opportunity may be lost, never to return.

H. B. Goodrich

Wesleyan University

Dr. George D. Olds, president of Amherst College, spoke of Amherst's past and present support of members of her faculty in research, endorsed the present movement for encouragement of college men in research and pledged Amherst's hearty cooperation.

Professor C. E. Seashore, dean of graduate studies in the University of Iowa, said that research is in the air in America to-day. He contrasted talent and creative ability in research, emphasizing the comparative rarity of creative ability. A man who has research in him will do research in spite of too heavy a teaching burden. The trend toward emphasis upon research is so strong in the whole life of the country that it will aid emphasis upon research in colleges, especially emphasis upon the research method in teaching.

Dr. Vernon Kellogg, permanent secretary of the National Research Council, said:

I have been impressed by the fact that so many of the students in professional schools and graduate departments of the universities have come from the colleges rather than from the undergraduate departments of universities. I asked the dean of one of the greatest graduate schools in regard to this and he said, "We get 90 per cent. from the colleges." This means that the students already have had the spirit of research cultivated in them in college.

I want to suggest that we pass a resolution at this meeting, as follows:

Resolved: That we recommend to the council of the American Association for the Advancement of Science that they invite the National Research Council, the American Council on Education, the Social Science Research Council, and the American Council of Learned Societies each to name a representative to meet a representative of the association, the five representatives to consider and enter upon definite plans for encouraging and promoting research in American colleges.

Dr. Kellogg's motion was passed at the meeting and later was approved by the council and was adopted by the association.

The members of this committee are: Vernon Kellogg, for the National Research Council; C. R. Mann, for the American Council on Education; Edward C. Armstrong, for the American Council of Learned Societies; Knight Dunlap, for the Social Science Research Council (interim appointment), and Maynard M. Metcalf, for the American Association for the Advancement of Science.

WILLIAM HEALEY DALL

The death of Dr. Dall on March 27, 1927, removes one of the last pillars from the fast disappearing class of systematic naturalists—a class whose roll of honor in America is adorned by the names of Audubon, Agassiz, Allen, Baird, Cassin, Cope, Coues, Dana, Gill, Hyatt, Kennicott, Leidy, Newberry, Packard, Richardson (Sir John) and Verrill. And it may be said with truth that in his chosen field no one of these labored more faithfully, or contributed more substantially to the advance of knowledge.

While Dall was primarily a conchologist, his interests were by no means confined to this specialty but reached out into many and divergent paths of scientific investigation. He was a student of nature in a broad sense—a naturalist in the full meaning of the term.

His early enthusiasm in the study of birds indicates the loss to ornithology when other work called him. For not only did he give us the first "List of Birds of Alaska" (1869), but his "Avifauna of the Aleutian Islands" (1873), still remains the authoritative source of published information on that extensive and then little known region. Similarly, his "Food Fishes of Alaska" (1871), his "List of the Mammals of Alaska with discussion of the Furbearing Animals" (1870), "Parasites of Cetaceans" (1872), and critical studies of the Cetecea with descriptions of new species (1873–1874) were marked contributions to the zoology of the time. His "Meteorology of Alaska" (1879) is a noteworthy volume, containing not only an elaborate summary of what was then known on the subject, but also maps showing the northern limit of tree growth and the distribution of plants and animals.

But the scope of his activities is by no means covered by the above enumeration, for in addition to his monumental contributions to conchology his publications enrich several other lines of research, notably anthropology, geography, tidal currents, geology and paleontology. Still other essays of which special mention should be made are those on evolution, on the geographic distribution of marine animals and on "Zoological Nomenclature"—the latter a painstaking and much needed work of timely service to systematic naturalists. And besides these Dall was the author of a number of monographic volumes and a multitude of lesser papers, chiefly on the Mollusca, and also of an appreciative biography of Spencer F. Baird—a volume of more than 450 pages, published in 1915. To one unacquainted with his indefatigable industry, the number, magnitude and quality of his published contributions to science is quite overpowering.

Dall, in common with most naturalists, developed an interest in natural history when so young that he was unable to recall the date. The accident that led him to become interested in shells was, he said, the possession when a boy of twelve of a copy of Dr. Gould's "Invertebrata of Massachusetts." Inspired by this work, and living near Boston, he undertook to make a complete collection of the shells of Massachusetts. Finding species that he was unable to name, he made bold to consult the author, Dr. Gould, who gave him much sound advice, and whom Dall characterized as "one of the best and most lovable of men."

A little later, when employed in an office on the India wharf in Boston, where he did boy's work for wages, he kept a book in his desk and at odd times when unoccupied with his regular task, copied scientific books which he then thought he would never be able to buy.

The next factor in shaping his zoological career was work in the museum at Cambridge, where he fell under the magnetic influence of Louis Agassiz. His third opportunity occurred in Chicago at the time of the Civil War, when, having failed to obtain a livelihood in Boston, he found employment in the Windy City. Although hard at work during the day, he spent his evenings studying at the Chicago Academy of Sciences.

It was there that he met William Stimpson and Robert Kennicott, both of whom became dear personal friends. It was there also that he determined, in the event of a choice of occupations, to accept irrespective of pay the one that promised most in the way of opportunity for continuing scientific studies. Acting on this resolve he more than once declined offers of higher salary and undertook harder work with less pay where there were better advantages for study.

In 1865 he visited Alaska as one of the scientific staff of the Western Union International Telegraph Expedition, and when his friend, Robert Kennicott, leader of the expedition, died on the ice of the Yukon, Dall, though only twenty-one years old, was unanimously chosen to succeed him. In 1867 he explored and mapped the mighty Yukon River from the coast up to Fort Yukon, then believed to be on or near the international boundary. On his return he published an illustrated volume on "Alaska and its Resources," (1870) comprising upwards of six hundred pages and a map, which for many years remained the standard authority on the territory. Professor Baird, appreciating his industry and talent, promptly took him into the fold of the Smithsonian Institution, which, except during absences on field expeditions, continued to be his headquarters until his recent fatal illness.

From 1871 to 1874 Dall was captain of a Coast Survey vessel and head of a scientific survey of the Aleutian Islands and adjacent coasts, the results of which, with much other material, were embodied in a quarto volume entitled the "Pacific Coast Pilot, Coasts and Islands of Alaska" (1879), prepared jointly by himself and his associate, Marcus Baker. The bibliography by Marcus Baker which accompanied it contains upwards of ninety titles of articles by Dall published prior to the year 1879.

From 1880 till his death he was an honorary curator the National Museum; from 1884 to 1925 he was aleontologist of the United States Geological Survey; from 1893 till 1927 he held the chair of invertebrate paleontology in the Wagner Institute of cience; and from 1899 to 1915 was honorary curator f the Bishop Museum, Hawaii.

He was the recipient of several medals and honorry degrees, including that of LL.D.

In 1899 Dall was one of the most eminent of the ientific guests of the late E. H. Harriman on the amous and unique Harriman Alaska Expedition. t is well within the truth to say that in view of the ast amount of work done by Dall during his thirteen revious visits to Alaska and in the preparation of is publications on the geography, geology, meteorolgy, anthropology and natural history of the territory, is knowledge was of the greatest service; while his enial disposition and readiness to answer multitudes f questions, both to individual members and at the vening gatherings in the cabin, made him the most eloved member of the expedition. To the series of hirteen volumes on the results of the research work f the voyage, he contributed a valued article on the "Discovery and Exploration of Alaska" and a beauiful and touching poem on the Innuit People.

Like Baird, under whose kindly influence many ears of his life were spent, his mind was a treasure ouse of information in various fields of science, eography, exploration and other subjects, and alhough one of the busiest men in the world, he gladly ave the benefit of his wide knowledge to earnest eekers for truth. To young men and women who ad chosen some branch of zoology or kindred science or their life work, he was always willing to lend a elping hand and was always patient, kind, helpful nd generous.

His own views as to the attributes and qualities hat go to make up a naturalist were expressed in n address on "Some American Conchologists" delivered in Washington more than forty years ago, in which he states, "The only lesson which may be said o be absolutely clear is, that naturalists are born, nd not made; that the sacred fire can not be extinguished by poverty nor lighted from a college taper. That the men whose work is now classical, and whose devotion it is our privilege to honor, owed less to education in any sense than they did to self-denial, steadfastness, energy, a passion for seeking out the truth, and an innate love of nature. These are the qualities which enabled them to gather fruit of he tree of knowledge." And it is obvious from the character of his own work that he believed that "what is worth doing is worth doing well."

My acquaintance with Dall dates back more than half a century, for it began in 1875 in the laboratory of the U. S. Fish Commission at Woods Hole, a favorite meeting-place for scientific men, then under the capable and friendly management of Professor Baird. Professor Verrill was in charge of the invertebrate studies, while among the laboratory assistants were Sidney I. Smith, Samuel F. Clarke, E. B. Wilson (then a mere lad), Tarleton H. Bean, and myself. William H. Dall, Alpheus Hyatt and David Starr Jordan were among the many who visited the laboratory or worked there for short periods.

It was the possession of such sterling qualities as intellectual capacity, patience, industry and thirst for knowledge, coupled with high ideals of integrity and obligation, that enabled Dall to attain the position he so long held among the eminent scientists of the world. The closing words of his appreciation of his friend William Stimpson may well be applied to himself: "Those who had the privilege of his companionship will carry an abiding memory of his abilities as a naturalist and his noble and lovable characteristics as a man."

C. HART MERRIAM

SCIENTIFIC EVENTS

PROFESSOR EINSTEIN ON NEWTON

On the occasion of the recent Newton bicentenary celebration Professor Einstein sent a letter to Dr. Jeans, secretary of the Royal Society, which in the English translation printed in *Nature* reads:

More than any other people you Englishmen have carefully cultivated the bond of tradition and preserved the living and conscious continuity of successive generations. You have in this way endowed with vitality and reality the distinctive soul of your people and the soaring soul of humanity. You have now assembled in Grantham in order to stretch out a hand to transcendent genius across the chasm of time, and to breathe the air of the precincts where he conceived the fundamental notions of mechanics and of physical causality. All who share humbly in pondering over the secrets of physical events are with you in spirit, and join in the admiration and love that bind us to Newton. What has happened since Newton in theoretical physics is the organic development of his ideas. Force became independent reality to Faraday, Maxwell and Lorentz, and then went over into the conception of the field. The partial differential equation has taken the place of the ordinary differential equation used by Newton to express causality. Newton's absolute and fixed space has been converted by the theory of relativity into a physically vital frame. It is only in the quantum theory that Newton's differential method becomes inadequate, and indeed strict causality fails us. But the last word has not yet been said. May the spirit of Newton's method give us the power to restore unison

between physical reality and the profoundest characteristic of Newton's teaching—strict causality.

THE FREEMAN FUND TRAVELING SCHOLARSHIP

THE American Society of Civil Engineers is about to take on a new activity as sponsor for a traveling scholarship in Europe. This was suggested in 1924 when Past-president John R. Freeman established a fund of the society "for the encouragement of young engineers," since designated as the "Freeman Fund." A part of the income, $1,800, has been made available for special study abroad during one year beginning July 1, 1927.

This period is to be devoted to a study of the theory and practice of hydraulics particularly as exemplified in the hydraulic laboratories of Europe, more especially those of Germany. For the present, candidates for this scholarship will be limited to junior professors, instructors, or assistants in American technical schools of recognized standing in which the study of hydraulics forms an important part of the curriculum. Brief progress reports addressed to the secretary of the society must be submitted each month by the holder of the scholarship for the information of the committee. At the conclusion of the year of study the holder of the scholarship shall submit to the society in form suitable for publication a monograph on current hydraulic practice in Europe and the work of European hydraulic laboratories. A complete statement of the conditions under which the scholarship will be awarded and full details of the requirements may be obtained from the secretary, 33 West 39th Street, New York City.

Similar funds for the encouragement of young engineers have been established in the American Society of Mechanical Engineers and the Boston Society of Civil Engineers, from the income of which it is expected that similar scholarships will be provided by each of these three societies, once in three years, so that continuously there will be one such traveling scholarship available. The income from this fund to each of these three societies amounts to nearly $1,700 per year.

Plans are now being formulated for utilizing that portion of the income which remains after providing for the scholarship once in three years by the society using it for special grants to aid in hydraulic research or for assistance in translating and publishing in English various useful engineering publications in foreign languages.

The first of these publications is to be that of a book on the hydraulic laboratories of Europe, written by fifteen of the foremost hydraulicians of Germany, Sweden, Russia, Austria and Czecho-Slovakia, and recently published by the national German engineering society, the "Verein deutscher Ingenieure."

AWARDS FROM THE MILTON FUND AT HARVARD UNIVERSITY

ANNOUNCEMENT is made at Harvard University of twenty-two awards to professors in the university in accordance with the provisions of the Milton Fund for research. This legacy, yielding an annual income of about $50,000, became available to the university in 1924. The awards include the following for scientific work:

Gregory P. Baxter, professor of chemistry, for two years, to carry on the experimental determinations of the compressibilities and temperature coefficients of gases at low pressure.

Henry B. Bigelow, lecturer and research curator in zoology, to purchase apparatus to be used on an oceanographic expedition planned for next summer, to study the dynamic cause of the Gulf Stream current off the North Atlantic coast of the United States.

Charles T. Brues, associate professor of economic entomology, to obtain collections for a continuation of his work on the adaptations of aquatic animal life to high temperatures.

Richard C. Cabot, professor of social ethics, to complete the work begun under previous grants on the effect of a prison sentence on the after-lives of 500 men who have been released from the Concord, Mass., Reformatory.

James B. Conant, associate professor of chemistry, to investigate the nature of the linkage between the protein and pigment in hemoglobin and the nature of the changes involved in the oxidation and reduction of the pigment.

William J. Crozier, associate professor of general physiology, to pay the salary of an assistant and to defray expenses incurred in an investigation of the nature of central nervous processes.

Harvey N. Davis, professor of mechanical engineering and Gregory P. Baxter, professor of chemistry, to pay the salary of an assistant, Dr. Howard W. Starkweather, and to defray the expenses incurred for apparatus and supplies, in determining the temperature of the ice-point on the absolute scale through measurements of the densities of argon and oxygen at various temperatures and pressures.

James A. Dawson, instructor in zoology, to pay the salary of a technical assistant and to purchase apparatus needed to investigate the nature and function of the so-called excito-motor apparatus in unicellular animals and also, by means of micro-injection, the nature of certain digestive processes in these animals.

Willard J. Fisher, of the Harvard Observatory, to develop and test apparatus for the photography of meteors.

Grinnell Jones, associate professor of chemistry, to continue his investigation of the properties of solutions of electrolytes. The sum will pay the wages of a glass blower and a mechanician and will enable the purchase of new apparatus and chemicals.

Alexander G. McAdie, Rotch professor of meteorology and director of the Blue Hill Observatory, to make a study of the electrification of clouds and fogs, part of a study of clouds and cloudy condensation in free air, the results of which it is hoped will contribute to the improvement of weather forecasts.

Frederick A. Saunders, professor of physics, to purchase a Moll recording microphotometer for use in research on the structure of spectra.

Alfred M. Tozzer, professor of anthropology and curator of Middle American archeology and ethnology, to pay the salary of a graduate student, working under the direction of Professor G. P. Baxter, who will chemically analyze metal objects from Yucatan.

William H. Weston, Jr., assistant professor of botany, to continue an intensive comparative study of a group of parasitic fungi which cause the several downy mildew diseases of important food crops.

Ralph H. Wetmore, assistant professor of botany, to assemble the more extensive collection of the genera Aster and solidago, to be studied later in the laboratory for the purpose of adding information to knowledge of cytology of hybrids and to the methods nature adopts in producing new forms.

The awards were made by the President and Fellows on the recommendation of a committee, the members of which are: Frank B. Jewett, electrical engineer, New York City; Professor Edwin F. Gay, of the Harvard Department of Economics, and Dr. W. J. V. Osterhout, formerly a member of the Harvard Faculty, but now botanist for the Rockefeller Foundation.

RENO MEETING OF THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION

The University of Nevada will act as host for the annual meeting of the Pacific division of the Association for the Advancement of Science to be held June 22 to 24 at Reno, Nevada. Preparations for this meeting are proceeding satisfactorily. President Arthur A. Noyes will attend the meeting as the president of the Pacific division and will deliver an address on "The Periodic Relations of the Elements." The selection of Dr. Noyes as president of the national association at the Philadelphia meeting in December followed his election as president of the Pacific division in June, 1926, so that he has the unique distinction this year of presiding over the general association as well as over its most considerable "division."

The membership of the Pacific division now includes about 1,500 members, a far larger number in proportion to population than that representing the rest of the country. The Reno meeting will be the eleventh annual meeting, previous meetings having been held in the order named at San Diego, 1916; Stanford University, 1917; Pasadena, 1919; Seattle, 1920; Berkeley, 1921; Salt Lake City, 1922; Los Angeles, 1923; Stanford University, 1924; Portland, Oregon, 1925, and Mills College, 1926.

At a recent meeting of the executive committee various details of the program for the Reno meeting were determined. A symposium on "The Scientific Problems of an Arid Region" will be presented by specialists under the subheadings of geology, physical chemistry of soils, botany and zoology. Research activities on the Pacific Coast will be considered at a conference when achievements in physics, chemistry, zoology, botany, astronomy and medicine will be reported. The personnel of these programs will be given in the preliminary announcement to be issued shortly.

Among other features of the general program will be an address by Professor Henry H. Dixon, of the University of Dublin.

The completion of the great national highway through Reno to the Pacific Coast makes this point accessible by automobiles. Eastern members who are enthusiastic motorists will be tempted to make the cross country trip. Auto camps, equipped with cabins and tents, are available in Reno for visitors who wish to use them. The usual summer tourist rates will apply from eastern points to the Pacific Coast with stop-over privileges at Reno. Further details regarding rates will be given in the preliminary announcement.

Nevada's Transcontinental Highway Exposition, to commemorate the completion of an improved road from the Atlantic to the Pacific, will open immediately following the meeting of the association. In a beautiful setting in Idlewild Park the exposition will offer displays of the varied resources of the western states. Nevada and California already have erected buildings to house their exhibits, while structures are being built to furnish space for other western states. Visitors to the association meeting will find much of interest at the exposition.

The entertainment committee of the University of Nevada have planned many excursions to points of scientific and scenic interest in the vicinity, while unsurpassed opportunities for fishing and sports will be available for those so inclined. Arrangements for the meeting are in charge of the executive committee of the Pacific Division constituted as follows:

Joel H. Hildebrand, *chairman*, professor of chemistry, University of California.

Arthur A. Noyes, director, Gates chemical laboratory, California Institute of Technology.

Walter S. Adams, director, Mount Wilson Observatory.

Bernard Benfield, consulting engineer, San Francisco.

Leonard B. Loeb, professor of physics, University of California.

E. G. Martin, professor of physiology, Stanford University.

Emmet Rixford, professor of surgery, Stanford University.
J. O. Snyder, professor of zoology, Stanford University.
O. F. Stafford, professor of chemistry, University of Oregon.

W. W. SARGEANT, *Secretary*

CALIFORNIA ACADEMY OF SCIENCES,
SAN FRANCISCO, CALIF.

SCIENTIFIC NOTES AND NEWS

THE sixty-third annual meeting of the National Academy of Sciences will be held in the building of the academy in Washington on April 25, 26 and 27.

THE American Philosophical Society will hold its annual meeting in Philadelphia on April 27, 28, 29 and 30. The occasion will be marked by the commemoration of the two-hundredth anniversary of the founding of the society.

THE regular spring meeting of the executive committee of the American Association for the Advancement of Science will be held in Washington on April 24. Matters to be considered by the committee should be in the hands of the permanent secretary a few days before the meeting.

THE trustees of Science Service will hold their annual meeting in Washington on Thursday, April 28.

DR. FREDERICK BELDING POWER, head of the phytochemical laboratory of the U. S. Department of Agriculture, from 1896 to 1914 director of the Wellcome Research Laboratories, London, distinguished for his contributions to pharmaceutical chemistry, especially to our knowledge of the essential and fatty oils, has died at the age of seventy-four years.

THE Council of the British Association has nominated Sir William Bragg as president for the meeting in Glasgow in 1928. The meeting in Leeds this summer is under the presidency of Sir Arthur Keith.

IT is announced by the Royal Geographical Society that the following awards have been made: The Founder's Medal to Major Kenneth Mason (Survey of India), for his connection between the surveys of India and Russian Turkestan through the Pamirs in 1913 and his organization and conduct of the Shaksgam Expedition of 1926; the Patron's Medal to Dr. Lauge Koch (of Copenhagen), for his six years' exploration of Northern Greenland; the Victoria Medal to Colonel Sir Charles Close, F.R.S., for his distinguished contributions to the advancement of the science of geography; the Murchison Grant to Mr. John Mathieson, for his surveys of Spitzbergen and for his special studies during his long service with the Ordnance Survey in Scotland; the Back Grant to Captain A. H. MacCarthy, for his preparation and leadership of the ascent of Mount Logan, 1925; the Cuthbert Peek Grant to Mr. Francis Rodd, to assist him in further exploration of the Sahara, and the Gill Memorial to Mr. A. E. Young, for his development of the mathematical theory of map projections.

PROFESSOR LAFAYETTE B. MENDEL, Sterling professor of physiological chemistry at Yale University, has been awarded the gold medal of the American Institute of Chemists.

DR. KARL LANDSTEINER, member of the Rockefeller Institute for Medical Research, has been elected a member of the German Academy of Natural Sciences in Halle, Germany. Dr. Landsteiner has also been elected corresponding member of the Society for Microbiology in Vienna.

OXFORD UNIVERSITY has conferred upon Dr. Arthur G. Tansley, Sherardian professor of botany in the university, the honorary degree of master of arts.

DR. HAROLD JEFFREYS has been awarded by the University of Cambridge the Adams Prize for the period 1925–26 for an essay on "The Constitution of the Interior of the Earth, and the Propagation of Waves through the Interior and over the Surface of the Earth."

DR. A. PENCK, formerly professor of geology at the University of Berlin, and Professor Gustav Braun, of the University of Greifswald, have been elected honorary members of the Danish Geographical Society.

AT the forty-ninth annual meeting of the British Institute of Chemistry, which was held in London under the presidency of Professor G. G. Henderson, Professor Arthur Smithells was elected president for 1927–28.

ACCORDING to *Nature* the British secretary of state has appointed the following as members of a joint committee for the management of the proposed Dairy Research Institute in Scotland: Sir Donald MacAlister (chairman); Professor Robert Muir and Professor D. Noël Paton, representing the University of Glasgow; Mr. C. Lindsay, Mr. John Speir and Principal W. G. R. Paterson, representing the West of Scotland Agricultural College; the Right Hon. Lord Weir, and Mrs. Houison Craufurd.

DR. RICHARD H. F. MANSKE, who received his doctorate in Manchester, England, under Professors Lapworth and Robinson in 1925, has been appointed a research fellow in Yale University to cooperate with Professor Treat B. Johnson on research dealing with the biochemistry of sulphur. Dr. C. Merle Suter, of the University of Kansas, has been granted

a Metz research fellowship in organic chemistry at Yale University for the college year 1927–28.

DR. JAMES R. WEIR, pathologist in charge of the mycological section, U. S. Bureau of Plant Industry, and who was for several years in charge of forest pathological investigations for the bureau in the northwest, and consulting pathologist for the United States Forest Service in that region, has been appointed pathologist for the Rubber Research Institute of Malaya at Kuala Lumpur, Federated Malay States. The institute has recently been organized and will have for its field of research all phases of the rubber industry in British Malaya. Dr. Weir will leave for the Orient in April.

TOM GILL, forester of the Charles Lathrop Pack Forestry Trust and formerly associate editor for the American Forestry Association, has become associate forester of the Tropical Plant Research Foundation, and will conduct a survey of the forest resources of tropical America supported by the Charles Lathrop Pack Forestry Trust.

FRED ALLISON has resigned as chief electrical and mechanical engineer of the Ford Motor Company to engage in consulting engineering work through H. R. Van Deventer, Inc., of New York City.

W. A. DUFFY has been appointed state commissioner of agriculture in Wisconsin.

DONALD R. MCMILLAN, the Arctic explorer, expects to sail from Wiscasset, Me., on June 28 for the far north as leader of the new expedition for the Field Museum, Chicago. The expedition will remain in the north for more than a year and will establish a shore station at Nain, Labrador.

DR. PHILIP E. SMITH, who was recently appointed professor of anatomy at Columbia University, plans to leave for Europe on July 1 for the purpose of spending several months in the clinics at Vienna.

DR. RUDOLPH MATAS, who recently resigned his professorship of surgery at Tulane University, accepted the invitation of the Royal College of Surgeons of England to attend the Lister Centennial in London, which took place from April 4 to 7.

DR. H. A. LORENTZ, professor of theoretical physics at the University of Leiden, who has been in this country since October lecturing at Cornell University and at the California Institute of Technology, is returning to Holland. He sailed from New York on April 7.

PROFESSOR RICHARD WILLSTATTER, of Munich, Germany, will deliver the sixth Harvey Society lecture at the New York Academy of Medicine on Saturday evening, April 9. His subject will be "Organic Chemistry—Its Application to Medicine."

DR. W. F. G. SWANN, director of the Sloane physics laboratory at Yale University, will address the Franklin Institute on April 14 on "What is left of the Atom."

DR. P. R. SHIPLEY, of the Johns Hopkins University, has accepted the invitation of the Biochemical Society of Jefferson Medical College to be the speaker at the fourth annual open meeting of the society in October. The former speakers have been Professors Charles R. Stockard, Cornell University Medical College; Wm. J. Gies, Columbia University, and H. G. Wells, Chicago.

DR. A. M. BANTA, resident investigator of the department of genetics of the Carnegie Institution of Washington at Cold Spring Harbor, N. Y., delivered an illustrated lecture on "Caves and their Inhabitants" before the honor society of agriculture, Gamma Sigma Delta, at the Kansas State Agricultural College on March 22.

DR. E. W. LINDSTROM, head of the department of genetics at Iowa State College, gave an address at Purdue University on March 25 on "The Modern Status of Genetics." The address was delivered at a joint dinner meeting of the Purdue chapter of Sigma Xi and the Purdue Biological Society.

ASSISTANT PROFESSOR ELBERT C. COLE, of the department of biology, Williams College, gave a public lecture at that institution on "Biology and the Biologist," on March 8. On March 17 Edward G. Reinhard, of the Buffalo Museum of Science, gave an illustrated lecture before the Science Club of the college, on "The Habits of Some Solitary Wasps."

DR. SIMON FLEXNER, director of the Rockefeller Institute for Medical Research, addressed the annual meeting of the Mount Sinai Hospital Society, New York City, on March 27, on "The General Hospital and Medical Research."

PROFESSOR K. T. COMPTON, of Princeton University, will be a member of the summer session staff in physics at Cornell University this summer, where he will give a course of lectures on the electron theory of matter.

THE Swedish Astronomical Society celebrated on March 18 the memory of Sir Isaac Newton on the occasion of the bicentenary of his death. His life and work were described in a lecture by Professor Charlien.

DR. WILLIAM EVERETT MUSGRAVE, known for his investigations on tropical diseases, formerly professor of medicine and dean of the college of medicine and surgery at the University of the Philippines, died on February 12, aged fifty-eight years.

Jesse Merrick Smith, consulting engineer and a former president of the American Society of Mechanical Engineers, died on April 1, at the age of seventy-eight years.

William S. Valiant, curator of the geological museum at Rutgers University, died on March 27, aged eighty years.

Dr. Corrado Donato Da Fano, reader in histology at King's College, University of London, died on March 14 at the age of forty-eight years.

Nature reports the deaths of Professor A. W. Scott, for fifty-five years Phillips professor of science at St. David's College, Lampeter, aged eighty-one years, and of Dr. Ludwig Radlkofer, long professor of botany at Munich, in his ninety-eighth year.

Dr. Carl Runge, professor of applied mathematics in the University of Göttingen, distinguished for his work as a mathematician and spectroscopist, has died at the age of seventy years.

Arthur Bolles Lee, known for his work on cytology and microscopy, died on March 3 at Clarens, Switzerland, aged eighty-eight years.

Mrs. Bateson would very much appreciate copies of letters written by her husband, the late Dr. William Bateson, to his American friends, to be used in preparation of a biography. They may be sent direct to Mrs. Beatrice Bateson, 25 Bolton Gardens, Kensington, London, S. W. 5.

The United States Civil Service Commission announces an open competitive examination not later than April 26 to fill the position of associate aquatic biologist at Beaufort, N. C., and vacancies occurring in positions requiring similar qualifications. The entrance salary for this position is $3,000 a year. The subjects to be considered are (1) education, training and experience, weight 70; (2) writings (publications or thesis, to be filed with application), weight 30. The ratings on the first subject will be based upon competitors' sworn statements in their applications and upon corroborative evidence.

The forty-first annual meeting of the Iowa Academy of Science will be held at the State University of Iowa, at Iowa City, Iowa, on Friday and Saturday, May 6 and 7, 1927. Nine sectional meetings will be held at this time: Bacteriology; botany; chemistry, inorganic and physical; chemistry, organic; geology, mathematics, physics, psychology and zoology. A special feature of the general meetings will be an address by Professor E. C. Stakman, of the Minnesota Agricultural Experiment Station, on "Racial Specialization of Pathogenic Fungi."

The fifteenth annual meeting of the Eugenics Research Association will be held at Cold Spring Harbor, on June 25, 1927. This year, as last, the meeting will be held jointly with the annual meeting of the American Eugenics Society.

We learn from *Nature* that the executive committee appointed to make arrangements for an International Botanical Congress in England in 1930 has decided that the Congress shall be held in Cambridge, commencing about the middle of August. The following officers have been appointed: *Chairman of the Executive Committee,* Professor A. C. Seward; *Treasurer,* Dr. A. B. Rendle; *Secretaries,* Mr. F. T. Brooks and Dr. T. F. Chipp.

A gift of $1,000,000 to establish a radiological institute for the study of cancer at Washington University School of Medicine has been announced. The work will include the study of the general diagnostic and therapeutic uses of the X-ray and other more powerful rays. The donors are the General Education Board and Edward Mallinckrodt, St. Louis, chemical manufacturer, and members of his family. Approximately $250,000 will be spent for a four-story building to house the institute and the remainder will be used as an endowment for research.

In addition to recently announced gifts of $1,013,000 to the New York Botanical Garden's endowment, the Carnegie Corporation has pledged $6,000 annually for a period of five years in aid of public, especially adult, education at the garden.

An arrangement has been made by Rutgers University by which Johnson and Johnson, pharmaceutical manufacturers, will provide support for carrying on certain investigations in problems related to pharmacy under the supervision of Professors Thomas J. Murray and Sumner C. Brooks.

According to the *Official Record* of the U. S. Department of Agriculture, big-game animals on reservations administered by the Biological Survey have, with the exception of antelope, increased notably during the last ten years. Although antelope have been seriously depleted by predatory animals, now that better control has been initiated they are again increasing. The increase in mountain sheep from the twelve introduced on the National Bison Range, Montana, in 1922, to about fifty in 1926, shows what can be expected when these game animals have protection. Buffalo, elk and other animals have increased to such an extent on this preserve that during the year it was found advisable to dispose of sixty-six buffalo as meat, and seven were shipped alive to public parks, while 388 elk were sold to a grazing and breeding association in Massachusetts to relieve the over-

crowded condition. The capture and removal of these elk was the greatest operation on record in this country of handling big game on a wholesale scale. The total number of big-game animals now on reservations administered by the Biological Survey is about 1,530.

Museum News states that the work of preparing the site of the new Chicago Zoological Gardens is progressing rapidly. The tract of 196 acres is being cleared preparatory to the excavations necessary for the artificial lakes and ponds. A seventeen-hundred-foot well is being drilled so that the park may be entirely independent as regards its water supply. Two lakes, one of twelve acres for boating and water fowl, and another of two acres for wading birds, are being excavated. Pools are also being prepared for the elephants and hippopotami. It is also planned to set out 2,050 trees in addition to the various plants and flowers, some of which are being grown in a greenhouse already on the site. By April it is expected that the entire site will be properly fenced in and that work on the various buildings will be started.

An organization called the Argentine Aerotechnical Institute (Institute Aerotecnico Argentino) was recently founded in Buenos Aires, according to an announcement by the U. S. Department of Commerce. The purpose of the new institution is to seek to make the country independent in the field of aeronautical engineering. The present members, who number 15, are a group of well-qualified and capable professionals, and therefore are in a position to produce the necessary initial effort. The institute will attempt to direct the course of aero engineering, and work for the establishment of factories of aerial and experimental material, at the same time spreading a knowledge of the principles of this subject by means of public lectures.

It is announced that there will be opened in New York City some time before next fall a cancer hospital, which it is said will be the largest in the world. It will be devoted to clinics, operation on and treatment of patients, and will have laboratories for research into the nature and cause of the disease.

UNIVERSITY AND EDUCATIONAL NOTES

An appraisal of the estate of Lewis B. Woodruff shows that Yale University will receive the residuary estate of $66,694 outright and $25,000 after the death of Frances Butler. The New York Entomological Hospital receives $10,000 for the publication of monographs on the society's activities.

American University will receive from the late Miss Mary Graydon, of Ridgewood, N. J., a total of $861,000, including bequests of $545,000, according to an announcement by Chancellor Lucius C. Clark. Gifts from Miss Graydon, which have been coming to the institution over a period of years, have helped substantially in sending the campaign for funds well over the $1,000,000 mark toward the goal of $6,000,000.

Ground has been broken for the basement of the plant science building at University Farm, St. Paul, to house the division of agricultural biochemistry of the University of Minnesota.

Work will start soon on a new twelve-story building for Tulane University of Louisiana School of Medicine at the site recently purchased on Tulane Avenue, New Orleans.

Dr. Edwards A. Park, Sterling professor of pediatrics at Yale University School of Medicine, has accepted the professorship of pediatrics and the position of pediatrician-in-chief of the Johns Hopkins Hospital, Baltimore, and will assume his new duties next September. Dr. Park succeeds Dr. John Howland, who died in London last June.

Dr. J. Earl Thomas, associate professor of physiology in the Medical School of St. Louis University, has been elected to the chair of physiology at Jefferson Medical College.

Dr. H. E. Enders has been made head of the department of biology at Purdue University.

Dr. D. R. Davis has been appointed assistant professor of mathematics at the University of Oregon.

H. L. Baldwin has been appointed associate professor of engineering at the University of Utah in Salt Lake City.

Dr. Pierre Masson, of the University of Strasbourg, Alsace-Lorraine, has accepted the professorship of pathology at the University of Montreal and the position of pathologist at Notre Dame Hospital. Dr. Masson was for many years at the Pasteur Institute, Paris.

DISCUSSION AND CORRESPONDENCE

THE FISH NEOSTETHUS IN SIAM

Among the most remarkable fishes brought to light during the present century, front rank, if not first place, must be assigned to three diminutive forms described by Mr. C. Tate Regan under the new generic names Phallostethus and Neostethus. *Phallostethus dunckeri*[1] was described from Johore, Malay Penin-

[1] "A Remarkable New Cyprinodont Fish from Johore." *Annals and Magazine of Natural History*, xii, 1913, pp. 548–555.

sula, and *Neostethus lankesteri* and *N. bicornis*[2] were described from Singapore and the Malay Peninsula.

These fishes, which attain a maximum length of thirty mm, have anatomical characters that are absolutely unique and entitle them to assignment to a new family. Regan gave them only subfamily rank, but Weber and de Beaufort[3] recognize the family Phallostethidae and place it in the new order Microcyprini of Regan, and Jordan[4] likewise gives full family rank in the equivalent order Cyprinodontes. The principal special characters of the family are absence of ventral fins, ventral aperture in the female between the pectoral fins, and the following extraordinary features in the male: a complicated fleshy appendage (priapium) suspended from the head and anterior part of the body, supported by one or both of the clavicles and one or both of the first pair of ribs, provided with special bones and muscles, and with separate anal, urinary and genital openings; attached to the aproctal side of the priapium posteriorly a single, slender, rod-like bone or a pair of such bones (ctenactinia) which may be long, curved and extended under the chin to the proctal side (Neostethus) or short, nearly straight and confined to one side (Phallostethus); and in Phallostethus another external bone (toxactinium) attached to the anterior part of the priapium.

This note deals primarily with *Neostethus lankesteri,* which until recently has been known only from six specimens obtained at Singapore and in the Muar River in southern Malaya. During the four years the writer has been in Siam he has become well acquainted with this fish, and he is probably the only student of fishes who has seen Neostethus alive. The species abounds in fresh-water pools, ditches and smaller canals in the Bangkok region and will doubtless be found to have an extended range. As there are no recorded observations on habits, food, eggs, etc., a few facts may be of interest.

The fish lives in water that is constantly muddy or turbid. It occurs in small, scattered schools which normally remain at or near the surface, and it feeds on planktonic micro-organisms. Small numbers put in balanced aquaria do well for a time but gradually die from starvation as the food supply becomes exhausted. By the daily introduction of raw ditch or canal water, fish in aquarium jars have been kept alive for a month and could probably be sustained longer.

[2] "The Morphology of the Cyprinodont Fishes of the Subfamily Phallostethidae, with Descriptions of a new Genus and two new Species." Proceedings of the Zoological Society of London, 1916, no. 1, p. 1–26.

[3] "The Fishes of the Indo-Australian Archipelago," IV, 1922, p. 381.

[4] "A Classification of Fishes," 1923, p. 160.

The larvae of Anopheles and other mosquitoes, which are the chief food of most of the small fresh-water fishes of this region, are entirely too large for Neostethus to ingest. The color of the back of the back harmonizes with that of the water in which these fish live, and they would be difficult to see when at or near the surface were it not for a triangular glistering yellow area on the top of the head with its apex on the nape. Viewed from the side the fish is transparent, the heart and abdominal viscera are distinctly visible, and the vertebrae may easily be counted.

The maximum length of specimens thus far measured is twenty mm, with the females averaging slightly larger than the males. Thus, in one lot of 108 adult fish, comprising forty-six males and sixty-two females, the largest number of males (twenty-eight) measured eighteen mm and none twenty mm, while among the females the largest number (thirty) measured nineteen mm and ten twenty mm; the average for males being 17.8 mm and for females 18.7 mm.

No observations on spawning habits have yet been possible. The extraordinary organ (ctenactinium) which in the male runs along the side of the head, extends under the lower jaw, and continues backward for some distance on the other side of the head may be used for clasping. The species is oviparous. The spawning period in Bangkok is protracted, corresponding with the rainy season and subsequent high water in river and canals (May to December). Fish with enlarged ovaries were observed in July; young nine mm long were collected in September and ten to twelve mm long in November; and eggs approaching maturity and numbering sixty-seven were dissected from a full-sized fish in November.

Not the least interesting thing about Neostethus is its possession of a structure not mentioned in Regan's description and not shown in his figures. This is a rather short, highly refractive spine situated a short distance in front of the dorsal fin. The spine is enclosed in or attached to a delicate membrane, may be elevated and depressed by the fish and is, in fact, a functional fin. The failure of so keen an observer as Regan to make any reference to this structure suggested to the present writer the possibility that the Siamese fish might represent another phallostethid type. However, an examination of Regan's material in the British Museum made at the writer's request has elicited the information from Mr. J. R. Norman, of that institution, that the types of both *Neostethus lankesteri* and *N. bicornis* show the structure referred to. Whether it occurs also in Phallostethus has not been stated.

The presence of this feature in Neostethus raises the question whether the family Phallostethidae can be retained in the order Cyprinodontes, none of the

other members of which have any vestige of a spinous dorsal fin. It seems certain that this family will have to receive reallocation.

American zoologists who may desire to examine this astounding little fish will be gladly supplied with specimens on request.

HUGH M. SMITH
DEPARTMENT OF FISHERIES,
BANGKOK, SIAM

CRITICAL POTENTIAL MEASUREMENTS

IN your issue of Dec. 11, 1926, there appeared an article by Dr. George Glockler on "Critical Potential Measurements: A Correction for High Emission Currents." The author notes that when the emission current becomes appreciable one must no longer consider the resistance of the tube to the infinite. He suggests that the p.d. between anode and cathode as calculated by a potentiometer scheme be corrected for this condition. I would like to suggest that there is nothing original in this suggestion. The tube simply acts as a shunt across a section of the potentiometer resistance and the calculations are carried out in precisely the same manner as for any shunted instrument.

I might add that I have used this correction factor for the last five years in measurements on vacuum tube characteristics. However, I have never regarded the matter as an original procedure.

JOHN G. FRAYNE
DEPARTMENT OF PHYSICS,
ANTIOCH COLLEGE

"DATA IS" OR "DATA ARE": WHICH?

IT is far from my desire to be unduly critical in regard to the use of scientific terms, but I have long hoped that some one would call attention to the incorrect use of the word "data" now too prevalent.

"Memorandum" and "memoranda," words seldom seen or heard now-a-days, seem to have been comprehended readily and honored by correct use almost invariably: why not "datum" and "data"? Yet in about one scientific article in six, often in those sponsored by institutions of the highest reputation, there will be found the careless, ignorant or indifferent use of these words. Sometimes the blame may be laid to inadequate editing, often where we least expect it; but primarily it is the fault of authors—even though their names are followed by a generous share of the alphabet, indicating that much time has been spent in scientific circles, and correctness should be expected. In the interest of scientific precision and to maintain proper standards it is time to call a halt on this unfortunate practice.

Probably the expressions "this men is" and "much children does" would grate even upon the sensibilities (at least, let us hope so!) of those who make use of "this data indicates," "much data has," etc.

A. P. MORSE
PEABODY MUSEUM,
SALEM, MASS.

THE INDICATION OF QUOTATIONS

MR. S. M. NEWHALL has recently[1] called attention to the need for a pair of equivalents, in oral speech, for the unwieldy phrases "quotation begun; . . . quotation closed."

May I suggest that we find in ordinary telegraphic language many instances of the reduction of such cumbersome expressions to others more concise, graphic, and effective?

In this case the usual rendering is "quote . . . unquote."

JOHN W. ARNOLD
WESTERN UNION TELEGRAPH COMPANY

SCIENTIFIC BOOKS

Coffee. By RALPH H. CHENEY, New York University. Pp. 244, 77 plates. The New York University Press, 1925.

THIS book is a very unusual combination of scientific research and practical information. It is a curious fact that coffee, one of the most familiar and important plants, has never before been adequately investigated. Cheney has certainly filled this gap in our knowledge in a most complete way, so that everything known about coffee is now on record.

Part I contains the scientific presentation of the botany of coffee. Its four chapters give in detail taxonomic descriptions of the nineteen known economic species. Associated with these scientific descriptions, much interesting information is given as to the native names, the history and the uses of coffee. The bibliographical references are remarkably complete, so that the whole literature of the subject is available.

Part II consists of an economic discussion of coffee. The story of the indigenous distribution of the economic species and the principal countries where they are now grown is most interesting. All these data are given with a wealth of detail that is surprising. A full description is also given of the preparation of the coffee-bean, the plantation treatment and the treatment by wholesale distributors. A very interesting chapter describes commercial sophistication and substitution, giving the botanical sources of coffee-substitutes and adulterants and also the methods of

[1] SCIENCE, LXIV, 427.

detection. An important chapter deals with the chemistry of coffee, which should be of great interest to investigators.

Having to deal with so many nations through such a stretch of time, Cheney has presented in two appendices an interesting ethnological discussion, showing the effect of the introduction of coffee on the political and social life of the metropolitan centers of Egypt, Arabia, Asia Minor, Europe and America. In the derivation of the term "coffee," Cheney presents a new theory, based on philological and botanical research backward through several oriental languages, and resulting, as is said, "in the correction of an error which has existed since the tenth century."

This book deserves wide attention, for it is a new kind of presentation of an important economic plant. A well-known coffee firm has made the following statement: "For exhaustive scientific research, for wealth of bibliographical reference to a species of plant life that has become a great economic factor, it is likely to be accepted as an authoritative and standard work."

JOHN M. COULTER

THE BOYCE THOMPSON INSTITUTE

SPECIAL ARTICLES

CONIFERS AND THE COAL QUESTION

FOR over a century and a half a controversy has raged in regard to the origin of that all-important mineral, coal. On the one hand it has been maintained that its raw materials are the result of transport by water and that consequently coal is essentially of the nature of an aqueous organic sediment. On the other hand, the opinion has been held that coal is in the main the result of vegetable accumulations similar to those in actual circum-polar peat-bogs, consisting of the subaerial deposits, representing successive generations of fallen peat plants. The first view of the origin of coal is usually called the allochthonous or transport theory. The second is known as the autochthonous or *in situ* hypothesis. European geologists have in the main in recent years held to the latter view and their American colleagues have for the most part followed them in this opinion. It is important to emphasize however that the earlier and even the current views in regard to the origin of coal are for the most part arrived at in complete ignorance of its organization. Except in very recent years figures revealing the organization of coal are conspicuously absent in geological works, even in those which particularly deal with coal. It is apparently not without significance that the French, who above all others gave early attention to the actual organization of coal, are supporters of the transport or aquatic hypothesis of the origin of coal. Although new methods and improved old methods now give us real insight into the organization of coal, there is as yet unfortunately in general little observable rational improvement in geological theories regarding the formation of coal deposits.

The Tertiary coals as being nearest to our times and consequently representing conditions most easily compared with those of to-day, suggest themselves as most likely to resolve finally existing controversies. In this connection the lignitic remains in a large number of Tertiary coals have been examined in the writer's laboratories with results which are apparently highly significant. It has long been the custom in central Europe to compare the Tertiary coals with such formations as occur to-day for example in the Dismal Swamp. The characteristic Conifer of such swamps is *Taxodium distichum* and the abundant remains of wood in German coal deposits were referred to this or a similar species under the generic name Taxodioxylon. A notable difficulty in this connection is the fact that the conspicuous "knees" or pneutamophores of Taxodium have never been found even in the often excellent preserved remains of supposed Taxodium stumps, in the central European brown coals.

Over two decades ago the present writer pointed out that a reliable diagnostic feature of our two living species of Sequoia is their reaction to wounds. In *S. washingtoniana* (the Big Tree) and *S. sempervirens* (the Redwood) resin canals are formed in the wood of the wound cap. This feature distinguishes Sequoia from all other genera possessing the Cupressinoxylon type of wood and holds also for the Laramie (upper) Cretaceous (the most remote epoch in which true Sequoias have been found). It now turns out that in many cases the supposed Taxodiums of the German Tertiary coals are in reality Sequoias. Both our living species of the genus are mountain trees and in no case are they ever found in swamps. As a result of this addition to our knowledge of the most important ligneous remains of the central European coal deposits, a change of view is necessary in regard to the conditions under which they have been accumulated. It is now admitted even by some of our German colleagues that there must have been inundations (Ueberschwemmungen) by means of which the remains of Sequoias, at that time abundant throughout the northern hemisphere, were washed into the coal bogs. Unfortunately this concession does not go far enough, for an examination of Tertiary coals, in the writer's laboratories, covering North America, Europe and Asia, shows not only the presence of Sequoias, but at the same time a general organization typical of the organic sediments found in the

depths of modern lakes, lagoons and tranquil estuaries. Tertiary coals in general, in the Northern Hemisphere, are consequently to be regarded as the result of water transport and aqueous sedimentation. Even so uncompromising an advocate of the autochthonous hypothesis as the late Professor H. Potonie, agreed that accumulations in lakes and ponds were to be regarded as allochthonous.

Recently, the writer has had the opportunity of studying brown coals of the Southern Hemisphere, in New Zealand and Australia. Here the evidence against the *in situ* or peat bog hypothesis of the origin of coal is equally decisive. The coals from a large number of New Zealand mines not only of Tertiary but also of late Cretaceous age shows organization such as is found to-day only in lacustrine or similar organic mucks. Further the woods of New Zealand coals belong to the Araucarians and Podocarps, Conifers, which are not found growing in bogs at the present time. It is not without significance too in this connection, that the official view of the Geological Survey of New Zealand, is that the coals of that country are of sedimentary or transport origin. In Australia the remarkable brown coal deposits near Morwell in the state of Victoria were examined under very favorable conditions, through the kindness of Sir Edgeworth David, of the Department of Geology, of Sydney University, and Sir John Monash, Chancellor of the University of Melbourne. These deposits are in places nearly eight hundred feet thick and in the open workings which are at present being operated are of a depth of nearly two hundred feet. In one of these are prodigious quantities of generally admirably preserved tree trunks, which in many instances have not undergone even the slightest compression. A microscopic examination of a number of these has shown that they are either Araucarian Conifers, or Proteaceae. The Araucarians are certainly not bog plants and the only reasonable explanation of their presence in coal deposits is their having been water-borne from some more or less distant site. The most characteristic Proteaceous wood present is that of the so-called silky-oak or Grevillea, which is a notable component of the well-known dry sandstone flora, so characteristic of Australia not only of to-day but as far back as the Eocene. The general organization of these coals is lacustrine like those of New Zealand and in places seams of actual oil-shale are present in the coal.

It appears advisable that more attention be given to the organization of coal, in connection with theories in regard to its origin. Certainly the prevailing views represent habit and prejudice rather than a rational consideration of the rapidly increasing body of new and significant facts. Not long since the writer was exhibiting the colored plates of his recent memoir on coal to two of his geological friends, one of whom remarked apropos of the brilliant hued illustrations, that coal did not look like that. He was advised by his fellow geologist to go and examine some coal sections. This advice may perhaps be of value in a wider circle.

It is clear from the structural study of Tertiary coals and their contained woods that these coals can not have been formed *in situ* as is generally assumed, since the woods are those of land and even desert trees. Further the general organization of brown coals closely resembles the aquatic accumulations of vegetable matter in the same regions at the present time and consequently can not be compared at all with peat.

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PACIFIC SCIENCE ASSOCIATION

The outstanding feature of cooperative scientific work in the Pacific for the year 1926 is the organization of the "Pacific Science Association"—the culminating action of the remarkable Science Congress which met at Tokyo, from October 30 to November 11, 1926. The objects of the association are:

(a) To initiate and promote cooperation in the study of scientific problems relating to the Pacific region, more particularly those affecting the prosperity and well-being of Pacific peoples.

(b) To strengthen the bonds of peace among Pacific peoples by promoting a feeling of brotherhood among the scientists of all the Pacific countries.

The constitution of the association provides for administration through a "Pacific Science Council" composed of members appointed by the research councils or similar organizations, located at centers where investigations of Pacific problems are now in progress. The charter membership consists of representative institutions in Australia, Canada, China, France, Great Britain, Hawaii, Japan, the Netherlands, Netherlands East Indies, New Zealand, the Philippines and Russia. Provision is made for the admission to membership of other countries as they develop active interest in Pacific problems.

In its organization, the Pacific Science Association presents some unusual features. It has no permanent officers and no specified place of meeting. The plan is to meet once in three years in response to an invitation extended by a responsible institution in some Pacific country; and to leave to the institution under whose auspices a meeting is held the entire responsibility for organization, financing, program and personnel. Between sessions, the work of the

association is to be carried on by "Standing Committees" appointed for the study of approved projects. Individuals and institutions have complete freedom of action under an implied agreement to follow a common program, to substitute sympathetic cooperation and teamwork for national, institutional and personal aggrandizement, and to freely interchange information regarding plans, work in progress and results of investigations. Another interesting feature of the association is the adoption of English as the official language.

The Pacific Science Association is the outgrowth of the realization that a knowledge of the people and of the resources of the Pacific is a prerequisite to intelligent thinking in regard to future commercial, social and political development. It is also the result of experience gained during the past decade through cooperative undertakings and of the knowledge attained through informal conferences in different countries and the more formal Pacific science congresses held in the United States (1920), in Australia (1923) and in Japan (1926).

The value of these triennial congresses is shown by the authoritative papers published in the Proceedings, by the successful completion of investigations recommended and by the increased recognition of the advantages of genuine international action. At the preliminary meetings held on the United States mainland during 1916–1919, few foreigners were present. For the 1920 conference, fifty-three "overseas" delegates came to Honolulu, thirty-four of them from the United States mainland; the remaining nineteen, from Australia, Canada, Japan, New Zealand and the Philippines. For the 1923 congress, the overseas delegates numbered seventy-nine, representing sixteen countries.

In planning the 1926 session of the Pacific science congress, the National Research Council of Japan set the number of "overseas" delegates and scientific observers at 150—a number which seemed generously large in view of the attendance at previous congresses. A relatively small attendance seemed also to be assured by the method of selection. Invitations were extended only to individuals who were actively interested in Pacific science. And as a means of procuring the presence of the men most desired, the National Research Councils of the different Pacific countries were asked to make the selections on behalf of the Japanese government on the basis of a specified quota. So great, however, was the interest that even after excluding administrative officials and eliminating honorary invitations, most of the quotas were exceeded and the number of appointed delegates who came to Tokyo surpassed the enrolment of any previous scientific gathering held within the Pacific area.

The official "overseas" delegations comprised 124 professional scientists and sixty-one scientific students and observers, and represented seventeen countries. In addition, Portugal and several Latin-American countries were represented by government officials—not scientists. The Japanese members of the congress, exclusive of administrative officials and committees, numbered about 380, thus giving a total membership exceeding 560. The largest group of "overseas" scientists came from the United States mainland—38; followed in turn by China—19; Australia—14; the Philippines—9; Russia—8; Netherlands Indies—8; Hawaii—7.

The remarkably large total membership involved grouping into sections, which also were large, thus assuring the presentation of many different views. The membership of the larger subdivisions was: Geology, including petrography, mineralogy, volcanology, mining and soil science, 80; medicine, including physiology, physiological chemistry and hygiene, 69; agriculture, 59; physics, 32; botany, including forestry, 52; zoology, including entomology, 46; engineering and architecture, relating chiefly to earthquake-proof construction, 27; geography and oceanography, 24; astronomy, 17; chemistry, 16; anthropology, 16; veterinary science, 14; geophysics, 14.

At the Japanese congress, more than 400 papers were presented under an admirably devised scheme of grouping, which allowed for discussion limited only by the time available. As at previous congresses, the chief attention was given to such subjects as food conservation, potential food sources, population, fisheries, the preservation of forest and soil, the geological structure of the Pacific, the history and status of native peoples. Underlying the formal papers, discussions and informal speeches was the feeling that in some way, not as yet fully understood, increase in scientific knowledge of the Pacific is of benefit to the people who now live and those who afterwards will live within and on the borders of the Pacific region.

That this belief is a guiding principle of the people of Japan is shown by their attitude toward the 1926 congress. To a degree heretofore unknown in international scientific gatherings, this congress was a national event, participated in by the imperial family, government officials, educators, business men, financiers, farmers and school children. In the true sense of the word, the overseas visitors were honored guests of the nation. So obvious was the feeling of goodwill that the congress seemed to be a group of friends gathered to discuss science rather than scientists welcomed to a delightful country.

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